C H A P T E R 1 9

Modems

This chapter presents the PC 99 requirements for modems, fax modems, voice modems, voice/data modems, wireless and cellular modems, and serial Integrated Service Digital Network (ISDN) adapters.

For communications that require a solution with bus-connected ISDN adapters based on NDIS under Windows and Windows NT, see the “Network Communications” chapter in Part 4 of this guide.

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PC 99 Modem Design Issues

This section presents the key design issues for modems. The Windows and Windows NT operating systems and Win32-based applications use data, fax, voice, and voice/data integration features in modems.

Note: Communications standards mentioned in this chapter are available through ITU Sales, Bellcore, ETSI, or Global Engineering Documents, as described in the "Modem References" section at the end of this chapter.

PC 99 Modem Basics. The fundamental design principle for compatibility with Windows is for the device to be supported by the Universal Modem Driver (Unimodem), which uses INF files to characterize the behavior of a device. A detailed definition of Unimodem requirements is contained in the MDK, available at ftp://ftp.microsoft.com/developr/drg/modem/modemdev.exe.

PC 99 requirements and recommendations are directed at the following issues:

- Dial-up access based on standardized pulse-code modulation (PCM) modems, based on ITU V.90.
- Migrating modem functions into the operating system to save costs and to provide upgrade flexibility.
- Augmenting modem functions to better support low-latency multimedia applications.
- Addressing persistent cost-of-ownership problems, particularly modem detection and installation and Internet Service Provider (ISP) call failures.

Migrating to Higher Speeds with PCM Modems. ISP access is the driving force for modem use. PCM modems enable the highest possible download speeds from central sites, such as ISPs, which are digitally connected to the Public Switched Telephone Network(PSTN). The ITU-T standard for such modems, V.90, was completed in February 1998.

Support for Low-Latency Multimedia Applications. As the use of natural data types such as voice and video has increased on the PC, so has the transport of such data across modem connections. The deployment of Web sites featuring real-time streaming sound and video has increased this trend.

The requirements for such data types are somewhat different than those imposed on modems by their traditional role as file transfer devices. Specifically:

- Data integrity, of critical importance in file transfer operations, is less important for voice or video.
- Because digitized sound and video tend to be highly compressed already, the data compression capabilities of modems often go unused.

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- Data latency, both average delay value and delay jitter, become very important for natural data types, especially for interactive applications. Latency is a minor issue for file transfer, because the total transfer time for the file is usually far greater than the delay value.
- Interruptions in data flow for data pump retrains or rate renegotiations, which are benign to file transfers, are intolerable for natural data types.

In order to address the low-latency demands of multimedia applications, the V.42 and V.42 *bis* protocol layers in the modem can be disabled. This removes the large buffering delays and data-forwarding jitter associated with these protocols. The Synchronous Access Mode procedures defined in ITU-T Recommendation V.80 can be enabled as an alternative to V.42 and V.42 *bis* in order to support low-latency, bandwidth-efficient connections.

On V.34 connections, data interruptions due to retrains and rate renegotiations can be reduced by the use of the Seamless Rate Change (SRC) procedures defined in new Annex A/V.34 (1998). SRC allows the modem to adjust its speed to match line conditions without disturbing the flow of data.

Addressing Cost of Ownership for Modems. The two largest cost-of-ownership issues for modems are installation problems and operations problems related to creating connections. Plug and Play minimizes installation problems when correctly implemented. However, the explosion in ISP usage has increased the percentage of modem connections made on local, as opposed to long distance, calls, and has highlighted operations problems on such connections. According to public studies, 16.2 percent of ISP access calls fail to connect, and ISPs are commonly spending $6 per subscriber per month in technical support.

A smaller percentage of access calls fail after the connection is made. This failure rate is not acceptable. Elements needed to change this are:

- Inclusion of impairments unique to local calls in industry-standard modem test suites, so that modem data pumps are designed and evaluated for such conditions.
- Modem and PSTN diagnostics, so that the causes of field failures can be identified.
- Modems that can easily be upgraded with revised code which was developed from the diagnostic feedback.
- Deterministic modem identification so that upgraded modems still work.

TSB-37A is the widely-used industry-standard model of the North American PSTN, used for evaluating the performance of modems. It simulates long distance telephone connections quite well. Investigation by some of the Regional Bell Operating Companies (RBOCs) has discovered however, that it does not account for certain impairments, specific to local calls, that may affect modem performance.

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TSB-37A is currently under revision; the revised standard, TSB-37B, will include accurate simulation of local connections. TSB-37B is expected to be completed in 1998, and its use should allow for a more accurate prediction of modem performance on local calls.

In consultation with leading ISPs and modem manufacturers, Microsoft is developing a standard method for modems to report last-call statistics: the Unimodem Diagnostics command, or AT#UD, as described in the specification on http://www.microsoft.com/hwdev/respec/. This command will be used by Windows and ISP software. The reported last-call information is essential to illuminate problems in user modems, local phone loops, local offices, and ISP-side modems so that they can be diagnosed and fixed.

After a problem has been found, requiring users to replace their modems to fix that problem is too costly for both the user and the manufacturer. Some manufacturers already make their modems with upgradable memory, allowing painless features or bug-fix upgrades for their customers. The makers of Windows-based modems have also offered this advantage. It is time to make easy user upgradability an industry-wide standard.

But even upgrades can pose hazards. For modems that do not support Plug and Play, the Windows Modem class installer reads a series of AT commands, implements a proprietary algorithm to generate a 32-bit ID, and uses that ID to match to the modem driver. Manufacturers might inadvertently change responses that Unimodem depends on for computing the unique Unimodem ID (AT+GM*x*, ATI, and other commands), leaving the user with a modem that is recognized as a "Standard Modem" instead of the actual modem name.

To address the detection problem, modem vendors are required to use bus-specific Plug and Play means to deliver the CompatibleID command, and they are encouraged to use standard methods to report accurate manufacturer and modem names. For information, see specifications for new Unimodem commands and related articles at http://www.microsoft.com/hwdev/hwdev/devdes/.

Migrating Functions to the Operating System with Windows Modems. A traditional modem has several functions implemented in hardware or firmware:

- Telephone network connection—connectors, transformers, relays, codec
- Digital signal processing—V.90, V.34, V.8 *bis*, dual tone multifrequency (DTMF), voice processing, speakerphone echo cancellation, and so on
- Modem controller—AT command interpreter (V.250)
- Protocol stacks—V.42 error control, V.42 *bis* data compression

A Windows modem moves some of these functions into Windows drivers. A controllerless modem (also known as a host-based controller) is a modem that consists of a digital signal processor (DSP) without the usual microcontroller.

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The host CPU provides the AT command interpreter, modem control functions, V.42, and V.42bis implementation.

A software modem (also known as host-based signal-processing modem or pumpless modem) performs signal processing on the host Pentium processor or compatible microprocessor and implements the controller as described in the previous paragraph. The modem hardware consists only of a telephone-line interface and DAC and ADC circuitry such as an AC ’97 2.0 modem codec, plus a little bit more. However, the hardware does not contain DSP or a microcontroller.

Advantages of software modems include the following:

- Cost savings
- Flexibility for upgrading to new standards, fixing bugs, and so on
- Data processing occurs in the CPU, where it fits. On many microcontroller-based modems, V.42 *bis* throughput is limited in some situations by available microcontroller processing power
- Separate data and control paths to the hardware are available

Disadvantages of software modems include the following:

- CPU-based functions compete for resources with other uses, such as the operating system, applications, multimedia codecs, and so on
- Dependent on a specific operating system environment in order to function. For example, a Windows modem does not function in the pre-boot environment
- Require Windows-savvy code development to ensure that the modem drivers are well-behaved in the system, and allow for straightforward installation and operating system upgrades

Controllerless and software modems are built as custom drivers which are required to run in real-time within the Windows environment. WDM modem support will provide a common interface so that one driver runs on both Windows 98 and Windows NT 5.0.

System Requirements for Modems

This section summarizes the PC 99 system requirements for modems.

1. Modem device is provided with PC system

Consumer PC 99	*Office PC 99*	*Entertainment PC 99*
Required	*Required, if no network adapter*	*Required*

Recommended: Internal modem, or use USB or PC Card as the external modem connection.

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Modem Basic Features

This section defines basic PC 99 hardware feature requirements for modems.

2. Modem supports V.250 AT command set
Required

ITU Recommendation V.250, formerly known as V.25 *ter*, is a superset of the TIA-602 basic AT command set with significant and useful improvements. It includes three new components:

- A standard format for extending the AT command set, with standard means for the PC to test the range of supported values for each command. This enables adaptive modem installation.
- Standard extensions for modem ID, port control, modulation control and reporting, error control, and data compression control and reporting. This reduces or eliminates the need for data-modem INF files.
- Related Recommendation V.251, formerly known as Annex A/V.25 *ter*, provides standard commands that enable the PC to use V.25, V.8, and V.8 *bis* call-control features for point-to-point data calls, voice/data/video calls, and voice-to-data transitions.

It is not required to implement every AT command, result code, and information text defined in V.250. If a particular function is not implemented in a modem or is not controllable via AT command, then the corresponding V.250 AT command need not be implemented.

However, any modem function controllable via AT command must be controllable by the appropriate V.250 command, if one is defined in V.250 for that function. (The function may optionally be controlled by a proprietary command as well.) Similarly, any reportable modem event must use the report defined in V.250, if one exists.

The essential V.250 commands are:

- All basic mode commands, from TIA-602 (no + prefix)
- Identification: +GMI, +GMM, +GMR
- Port control: +IPR, +ICF, +IFC, +ILRR
- Modulation: +MS, +MR, +MA
- Error control: +ES, +ER, +EB, +ESR, +ETBM
- Compression: +DS, +DR

The modem must also be able to generate appropriate V.250 responses enabled by the +ILRR, +MR, +ER, and +DR commands. The particular utility of the standard format is that it allows a future modem installer to adaptively install and use a modem, with minimal need for INF file minidrivers.

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3. Data modem supports V.90 (1998) analog modem modulation
Required
V.90 modulation supports PCM connections to digitally-connected central sites, at data rates from 56 Kbps down to 28 Kbps. V.90 support implies support for V.34, which is used for analog-to-analog connections, and for connections to central sites from users whose telephone lines do not support V.90 operation, at speeds from 33.6 Kbps down to 2400 bps.

4. Data modem supports Annex A/V.34-(1998) Seamless Rate Change
Required
V.34 SRC enhances performance during data mode, as data pump speed changes take place without blocking data flow. It also may allow a faster startup procedure, as the data pump can then quickly converge on a sub-optimal slower initial speed, and then rate-change up to higher speeds as the pump training is refined.

5. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set
Required
The following are recommended:

- Class 1.0 (ITU T.31) with +FAR support, which allows the hardware to perform adaptive carrier detection
- Class 2.0 (ITU T.32 or TIA-592) for rack-mounted server modems
- Adaptive DATA/FAX call classification based on the Class 2.0 +FAA command or equivalent (for example, +FAE), particularly for rack-mounted server modems
- V.34 Half Duplex (33.6 Kbps) modulation, controlled by Annex B/T.31 procedures

Windows is bundled with fax-modem support. Windows NT 5.0 and future versions of Microsoft BackOffice® products will support Class 1.0 and Class 2.0 fax modems and use adaptive FAX/DATA call-classification support. To benefit from this support, modem vendors should extend their modem INF files to support the new registry keys that are needed to support these features, as defined in the MDK.

6. Data modem supports V.42 LAPM, V.42 *bis,* V. 80 Synchronous Access data protocols
Required
The V.42 LAPM error control procedures, together with the V.42 *bis* data compression procedures, are particularly well-suited to traditional bulk data delivery modem applications.

The Synchronous Access modes defined in Chapter 8 of V.80 allow the data protocols in the modem to be bypassed and allow any arbitrary, non-traditional protocol to be implemented in the host. For example, it allows host-based V.70

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Simultaneous Voice/Data or host-based H.324 video telephony systems to be implemented. It should be noted that Chapter 8 of V.80 requires that both Framed sub-Mode and Transparent sub-Mode be implemented in order to comply with that section of the Recommendation.

Because V.42 LAPM is the default mode of operation in most modems, it is commonly used when accessing ISPs. The asynchronous (that is, character-oriented) form of the Internet Point-to-Point Protocol (PPP) is then run on top of LAPM. For enhanced, lower-latency performance for such applications as Internet Telephony, V.80 can be used together with the synchronous form of PPP. V.8 *bis* can be used to negotiate the use of V.80.

In particular, the AT+ITF command defined in V.80 is particularly useful in reducing the buffering delays in the modem transmitter.

7. Modem supports V.8 *bis* call control signaling, controlled via V.251 modem commands

Required

Recommendation V.8 *bis* provides for the negotiation and selection of call functions between endpoints, and enables smooth voice-to-modem transitions during a call. V.8 *bis* is required for multimedia modes such as V.61 ASVD and V.70 DSVD, and is used to negotiate the use of manufacturer-specific modulations and features. V.8 *bis* defines code points for V.42 and V.80 modes of operation. It enhances the basic call function selection embodied in the recommendations for V.25 and V.8. Support for these two recommendations is mandatory in V.90 and V.34 modems.

V.251 (formerly Annex A/V.25 *ter*) enables the PC to participate in call control, allowing flexibility and a visual user interface as well as saving modem complexity. At a minimum, the V.251 implementation must support DCE-controlled V.8 operation with DTE notification, and DTE-controlled V.8 *bis* operation. Means must be provided to turn on the V.8 CI (Calling Indicator) signal for originating calls.

8. Modem supports delayed and blacklisted number clearing

Recommended

This is recommended for modems supporting delayed and blacklisted number tables.

The modem should clear its delayed and blacklisted number tables if the associated handset goes off hook.

During certain international PTT certification processes, modems must support the delayed and blacklisted numbers feature. That means that when the modem fails to connect to a specific number for a certain number of times, the dialed number is stored in an internal list. Any subsequent automated dialing operation to this number is then either delayed for a time (delayed) or might be forbidden until

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some form of manual intervention occurs (blacklisted). The international certification processes specify that manual intervention using an external device is required in order to clear these numbers.

Windows will provide error messages corresponding to delayed and blacklisted error reports in order to reduce customer confusion.

9. Modem supports TDD, meeting V.18-1996 with V.250 AT commands
Recommended

People with deafness or reduced hearing can use Telephone Device for the Deaf (TDD), also known as Text Telephones, to communicate over phone lines. The U.S. Americans with Disabilities Act (ADA) requires all businesses of a certain size or larger to have Text Telephone services available and to be able to receive calls from people using Text Telephones.

In North America and Europe, the following types of Text Telephones are used:

- Baudot: 45 or 50 bps Frequency-Shift-Keyed (FSK) and 5-bit Baudot coding
- ASCII: 300 bps Bell 103 and 7-bit ASCII coding
- European Deaf Telephone (EDT): 110 bps half-duplex V.21 and 7-bit coding
- Minitel: V.23 modems and 7-bit coding
- Modems and 7-bit coding
- DTMF: 2-digit or 3-digit character coding

ITU recommendation V.18 codifies how all these devices work and how to adaptively connect to all of them. ITU recommendation V.250 (formerly V.25 *ter)* contains AT commands for control of V.18 features in a modem: +MV18S, +MV18R, +MV18AM, +MV18P.

It is recommended to include Text Telephone capability for the type commonly used in the country of sale and use (for example, Baudot in the United States, Minitel in France, and so on).

10. Modem controller meets PC 99 requirements
Required

The following are PC 99 requirements for the modem controller, in addition to those stated above:

- Unimodem Diagnostics command, AT#UD
- Software-upgradable modem controller (that is, upgradable ROM or Windows driver-based modem)
- AT command buffer of at least 60 characters
- Semicolon (;) character dial string modifier (except when the modem is configured for operation in those countries which prohibit this dial modifier)
- V.250

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In addition, for compatibility with some non-TAPI legacy applications, the ATW2 command should be supported. Use of this command specifies that a string specifying the receiver line bit rate is appended to the CONNECT result code.

Voice Modem Requirements

Voice capabilities are not mandatory, but if present, the following requirements and recommendations apply.

There is a separate category of voice-only device that can be integrated with a telset. These devices are not required to support modem data or fax, but the following requirements do apply.

11. Voice modem supports ITU V.253 (AT+V)
Required (in modems supporting voice)
TIA IS-101-1994, the interim standard for Voice DCE, has been superseded by TIA-695. TIA-695 adds voice formats and speakerphone control commands. ITU-T V.253 (formerly V.voice) was completed in January 1998 and is a superset of the TIA-695 U.S. standard. V.253 includes some small corrections to TIA-695 and adds provisions for duplex voice.

The following voice modem features are required:

- Voice recording and playback
- DTMF generation and detection during voice I/O
- Voice I/O support of 8-bit, 8-kHz PCM formats: unsigned linear, G.711
- Programmable gain control for all audio channels
- Voice I/O to the handset (required only for voice-only devices)
- Full duplex voice I/O to the host, with echo cancellation for speakerphone operation

12. Voice modem support includes PC 99 recommendations
Recommended
The following voice modem features are recommended:

- Sense local telephone line state (ready, busy, disconnected) without going off hook
- Extension telset answer and hang-up detection and reporting
- Programmable gain control for all audio channels
- Remote telset answer and hang-up detection and reporting
- Message waiting signal (stuttered dial tone) detection reporting
- Special Information Tone (SIT) detection and reporting
- Distinctive ring detection and reporting

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- Powered interface to the local telset to support voice I/O and DTMF I/O

13. Modem supports Caller ID Detection and Reporting
Recommended

Caller ID reporting is controlled with the AT+VCID and AT+VRID commands. Note that, as specified in V.253 Caller ID reporting is available in operating modems other than Voice Mode; that is it is available in FCLASSs other than 8. Therefore, it is recommended that the modem support the AT+VCID and AT+VRID commands even if Voice Mode is not supported.

14. Voice modem supports speakerphone
Recommended

Audio I/O for speakerphone can be implemented in any of the following ways:

- Full-duplex digitized audio to host. This support is appropriate for voice/data/fax modems using PC audio peripherals and is essential for PC Card modems, which lack the connectors for external audio I/O. This is the preferred speakerphone implementation.
- Jacks to external audio I/O (that is, microphone and speaker or handset jack). Such jacks are optional but, if included on the modem, speakerphone operation should be supported through them.
- Built-in audio I/O (microphone and speaker). This support is appropriate for voice-only non-modem devices (that is, PC-connected phones).

Wireless and Cellular Modem Requirements

This section provides PC 99 requirements and recommendations for wireless and cellular modems.

15. Wireless support implemented for modems
Recommended

There are a variety of wireless modems and look-alike modems. These include the common types: North American analog cellular, global system for mobile communications (GSM) and other digital cellular systems, cellular digital packet data (CDPD), and so on. However, there are several other types, such as the Ricochet modem from Metricom.

Windows has registry keys that support analog cellular modems. Windows also supports data access in GSM and other wireless modem types. Participants in the Mobile Data Initiative are developing extensions for other services on digital cellular modems, as described in the following item.

For all wireless and cellular modems, the commands in TIA-678 are recommended. The +WS-46 command, which selects the wide area network (WAN), is required.

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16. Digital cellular phone support is implemented for modems

Recommended

Digital cellular support is not a requirement, but if implemented, the following appropriate digital cellular control standards must be supported:

- TIA-678 +WS-46 selector command
- +CSQ signal quality monitoring command
- +CBC battery power monitoring command
- +CPAS phone activity status
- Class 2.0 facsimile services, per appropriate standard
- For GSM modems, +CBST protocol selection command

To allow software applications to use SMS (that is, specify settings and manipulate SMS) through a GSM modem card, it is recommended that the card support the following GSM 07.05 commands.

- +CSMS: Select Messaging Service
- +CMGF: Message Format
- +CSCA: Service Center Address
- +CNMI: New Message Indications to TE
- +CSCS: TE character set selection
- +CMGL: List Messages
- +CMGR: Read Messages
- +CMGW: Write Messages
- +CMGS: Send Messages
- +CPMS: Preferred Message Storage
- +CSAS: Save Settings
- +CRES: Restore Settings

Unlike wireline data modems, these devices are not required to support V.34 signaling; it is not available. 9600 bps capability is required; higher speeds are recommended where available. Class 1.0 fax support is available on some of these devices, but it is not required; the error rates with transparent modem faxes are often very high.

Cellular telephone systems are widely deployed in the industrialized world and are now being deployed internationally. In North America, analog cellular systems (TIA-553) are currently predominant, although two types of digital cellular systems can also be deployed: code division multiplexed access (CDMA, TIA IS-95) and time division multiplexed access (TDMA, IS-136).

In Europe and the rest of the world, the GSM digital cellular system is widely deployed. In Europe, the infrastructure for data, fax, and short messaging is now in place.

For all three digital cellular systems, the system design has been extended to offer data, fax, voice, and short messaging service (SMS) to mobile users. In all cases, a modem pool is added to the ground stations, where connection is made to the PSTN. Access to the logical serial ports of these modems is made using the digital error-controlled radio link to the equipped mobile phone and is exposed on a serial port or associated PC Card.

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Digital cellular communications equipment should default to using error correction on the radio link. For example, for GSM 7.07, the modem should initialize to +CBST=,,1 (which selects a “nontransparent” air interface).

To allow datacards to use GSM/ISDN V.110 “fast access” where available in the network, +CBST=71, , (9600 bps V.110) should be a valid setting.

The AT command sets for these digital cellular phone systems are contained in the following standards.

Standard	Command set
GSM 7.07	GSM system: data, fax, voice
GSM 7.05	GSM SMS
TIA IS-99	North American CDMA: data and fax
TIA IS-135	North American TDMA: data and fax

The TIA-678 +WS46 command has codes to indicate which system the modem is capable of. For example, the following values, quoted from Table 4 of the standard, are useful.

Value	System
1	Public telephone network (that is, a normal wireline modem)
4	Cellular Digital Packet Data (CDPD)
7	TIA-553 analog cellular system
10	Metricom Ricochet network
12	GSM digital cellular system
13	TIA IS-95 CDMA digital cellular
14	TIA IS-136 TDMA digital cellular (“PCS”)

ISDN Modem Requirements

There are two classes of ISDN adapters: (1) parallel bus devices, supported by NDIS WAN drivers, and (2) serial port devices, supported by Unimodem with INFs. This section addresses serial ISDN adapters, colloquially referred to as ISDN modems.

For a general discussion of ISDN and a list of requirements related to parallel bus devices, see the “Network Communications” chapter in Part 4 of this guide.

ISDN modems share the following features:

- ISDN Basic Rate interface (2B+D)
- Serial AT command language, with proprietary ISDN extensions

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ISDN modems also share the following differences from wireline PSTN modems:

- User (or device) must configure for switch type and service profile ID (SPID)
- Data only, in increments of one or two 64,000 bps B channels
- Fax not available
- V.42 and V.42 *bis* usually not available

17. ISDN modem supports required command set

Required

An ISDN modem must support basic AT commands (TIA-602, which is a subset of ITU V.25). The ISDN modem shall support commands to select the end-to-end protocol used over the ISDN (for example, synchronous PPP, V.110, V.120, and so on). Also, commands to set the switch type, subscriber numbers or directory numbers (where applicable), and SPID or EAZ (where applicable), for user selection or if auto-detection fails, must be included. These can be implemented in the device or in the communications driver.

~~**ISDN modem supports auto-SPID detection algorithms and standard SPID format**~~

~~*Required*~~

~~An ISDN modem must include commands or means to support software-based automatic switch type and SPID detection using the algorithms as defined by the National ISDN User's Forum (NIUF) in *1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines.* This eliminates the need for the end user to enter the SPIDs.~~

~~An ISDN modem must include commands or means to support software-based automatic switch type and SPID detection using the algorithms defined by NIUF. This eliminates the need for the end user to enter the SPIDs and enhances the Plug and Play experience for users.~~

~~This requirement applies only in the United States.~~

18. ISDN modem exposes both B channels

Recommended

ISDN modems should expose both B channels so that they can leverage the multilink PPP support included in the operating system.

Multilink PPP, as defined in RFC 1717, combines several ISDN B channels to increase the bandwidth of PPP links.

When using ISDN modems connected to the PC via single serial port, these capabilities included in the operating system cannot be leveraged and the users may not be able to fully benefit from the features in the ISDN device, such as support of two B-channels and combining them into one fast link.

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This is because Windows cannot see both B channels of the ISDN connection unless each B channel is exposed to the operating system, either as a COM port or via NDIS.

External ISDN modems should be on port fast enough to expose the full bandwidth of both B channels, that is, USB. Providing two separate COM-port cables is not an acceptable solution.

19. ISDN modem supports asynchronous-to-synchronous conversion
Required

These types of ISDN devices are treated as modems, not as internal ISDN devices supported using NDIS WAN miniports. In the external case, the primary implication is that the operating system will send byte-level PPP (also known as asynchronous PPP). In the NDIS WAN case, the implication is that the operating system will send bit-level PPP (also known as synchronous PPP).

Because ISDN is a synchronous service and an ISDN modem connects to an asynchronous port on the PC, the device must provide some means of converting asynchronous data to synchronous data.

20. ISDN modem defaults to HDLC PPP after INF installation.
Recommended

An ISDN modem may support multiple end-to-end protocols, but it should default to synchronous PPP (FRC 1662), which are used by the Microsoft's Remote Access Services (RAS) and Dial Up Networking (DUN) protocol stacks.

21. ISDN modem uses high-speed port
Recommended

Because of speed limitations inherent in a PC's COM ports, the connection for ISDN modems should be high-speed, such as USB or IEEE 1394. A specification for controlling an ISDN TA over USB is in development by the USB Communications Device Class working group.

~~**ISDN driver supports switch detection**~~
~~*Recommended*~~

~~The driver can attempt to determine the switch type based on the directory number, or it can use other proprietary solutions to determine the switch type. This enhances the Plug and Play experience for users.~~

22. ISDN driver supports unattended installation, with limitations
Required

Configuration of the dependent parameters, such as SPIDs and switch-type IDs, must be done via the ISDN Configuration Wizard included in the operating system.

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Basic Modem Performance

This section presents performance-related recommendations and requirements.

23. Modem pair passes basic V.34 file transfer test
Required

While operating in V.34 modulation on TIA TSB-37A line 18C2, the modems are able to transfer 256 repetitions of the TSB-38 test file **4.TST** in 40 minutes or less, simultaneously in both directions, without hanging up or otherwise aborting the transfer. V.42 LAPM is enabled during this test. Data transmission runs directly on the modems without the use of an additional protocol such as Zmodem.

Impairment combination 18C2 in the TIA TSB-37A PSTN consists of very mild impairments. No V.34 modem should have difficulty operating on this line at least 31.6 Kbps.

TIA standard TSB-38 specifies test procedures for evaluating modems. Test file **4.TST** contains random data and does not benefit from data compression.

This requirement is a basic test of modem functionality and verifies that the modem is able to connect at 31.~~6~~ 2 Kbps, stay connected, and transfer data on a clean line for at least a half hour, which is a typical time period for a modem session.

Note: For modems certified for operation only in those countries outside of North America, impairment combination 2C4 as specified in ITU-T Recommendation V.56 *bis*, may be substituted for TSB-37A line 18C2. Recommendation V.56 *bis*, is an international equivalent of TIA TSB-37A.

24. Modem pair passes basic call connect reliability test
Required

While operating in V.34 modulation, the modems are able to perform 4 repetitions of the Call Connect vs. Test Loop Combination test defined in TIA TSB-38 (476 total connection attempts), with an overall call completion success ratio of 97 percent, and with neither modem “hanging” in an unresponsive, inoperable state.

As specified in TSB-38, the test channels 17C1 though 17C7 are used in this test because impairment combination 17C represents more than 55 percent of the combinations in the PSTN model defined in TSB-37A. ~~[Note, currently there is no corresponding ITU recommendation.]~~

At the conclusion of each connection or connection attempt during the test, the modem port will be closed and then reopened for the next attempt.

This requirement is a basic test of modem functionality and verifies that the modem can reliably connect a large number of times on good telephone channels.

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Note: For modems certified for operation only in those countries outside of North America, the Call Connect Reliability Test specified in ITU-T Recommendation V.56 *ter*, may be substituted for that in TSB-38. Recommendation V.56 *ter*, an international equivalent of TIA TSB-38, specifies use of the PSTN model defined in Recommendation V.*56* bis.

25. Modem pair passes concurrency test

Required

All modems will be tested for use with a PC. In this series of concurrency tests; the modem will run while a series of representative communications applications (for example, email, web browsing, and H.263+ video-teleconferencing) are running. A standard concurrency test procedure will be developed and published as part of the Modem Compatibility Test suite.

Driver-based Modem Guidelines

Items in this section are applicable to Windows driver-based modems.

26. Software modem meets PC 99 performance criteria

Recommended

Software modem is one of the first computationally intensive services where third-party vendors are providing kernel--mode drivers that can have significant impact on operating system scheduling services. To assure reasonable system performance to the end user, this guide introduces these performance guidelines for software modems.

These guidelines are primarily meant to guide designers in the development of the next generation of WDM-based software modem implementations. The instrumentation techniques suggested may not be applicable to industry standard external “black box” testing of modem performance.

Similar guidelines may need to be established for other services and drivers, as support moves into kernel mode. As an example, DirectSound 3D, DirectMusic, software MPEG and AC-3 decoders for DVD are currently implemented as user mode services.

[Note to reviewers: The values below are tentative and offered for comment and discussion as to the appropriate values for each parameter.]

The following processor usage guidelines refer to performance on the minimum processor required ~~recommended~~ by this guide for a Consumer PC 99—that is, a 300 MHz processor and 128 KB of L2 cache or equivalent performance, as defined in the “PC 99 Basic Requirements” chapter:

- The driver interrupt period or cycle time for computational processing needs to be short enough so that the signal processor can be responsive to line events, yet long enough so that system context switching overhead is not

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excessive. Cycle times in the range ~~Values~~ of 5~~-20~~ to 16 milliseconds are ~~reasonable~~recommended. The 5 millisecond minimum ensures low interrupt and task switching overheads. The 16 millisecond maximum establishes an upper bound for continuous execution at real-time thread priority, which can impact the minimum size audio buffer that can be used for low latency audio during software modem sessions. ~~-~~In subsequent guidelines, the examples are based on the ~~use 12~~6 millisecond maximum~~s~~.

[Note to reviewers: Is the 5-16 millisecond range specified above reasonable? Please provide us with specific feedback if your cycle times fall outside of this range.]

- In data transmission mode the *average* processor usage by a driver-based V.34 or V.90 modem should not exceed 25 percent. For example, processor usage should not exceed ~~3~~ 4 milliseconds every ~~12~~ 16 millisecond interval.
- In data transmission mode the *total* processor usage by a driver-based modem ~~during any 12 millisecond~~interrupt period ~~interval~~ should not exceed ~~6 milliseconds~~50 percent of any period equal to the cycle time. F~~, for~~ example, ~~6~~8 milliseconds out of a 1~~2~~6 millisecond period. This accommodates back-to-back service of double-buffered tasks, while leaving adequate processing time available for low latency audio.
- In (re)train mode the average processor usage by a driver-based modem should not exceed 50 percent. For example, processor usage should not exceed ~~6~~ 8 milliseconds every ~~12~~ 16 millisecond interval.
- In (re)train mode the total processor usage by a driver-based modem ~~during any 24 millisecond interval~~2 consecutive interrupt periods should not exceed ~~18 milliseconds~~75% of any period equal to twice the cycle time. F~~, for~~ example ~~18~~24 milliseconds out of a ~~24~~32 millisecond period. This accommodates atypical usage peaks of very short duration, such as back to back service of double buffered (re)train mode tasks, while leaving adequate processing time available for low latency audio.

  Measurement: Implementers can verify that their driver meets these guidelines ~~b) and d)~~ by using a profiling tool such as VTune or by instrumenting their code to use the Pentium II processor time stamp counter model specific register or equivalent ~~to record when each driver schedulable entity (for example, ISRs, DPCs and threads) starts and stops processing. By running the driver on an otherwise unloaded system the amount of misattribution due to preemption can be rendered inconsequential~~. As usage includes system calls made by the driver as well as operating system overhead incurred to schedule DPCs and threads, profiling measurements should be made using differencing techniques which compare driver plus operating system utilization in active and inactive states.

- The maximum time during which a driver-based modem disables interrupts should not exceed 100 microseconds. Furthermore, the total time during which a driver-based modem has disabled interrupts should not exceed

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200 microseconds during any 1 millisecond interval (this accommodates back-to-back interrupt servicing). Implementers can verify that their driver meets this guideline by instrumenting their code to use the Pentium II processor time stamp counter model specific register or equivalent~~, as described above~~.

- WDM makes kernel mode threads with real-time priorities available to driver writers, minimizing the need to perform extended processing with thread scheduling disabled. Computation in WDM DPCs is highly non-preemptible because it takes place with thread scheduling disabled and because DPCs execute non-preemptively with respect to other DPCs. It is therefore desirable to limit the amount of such computation in order to maintain system responsiveness and minimize the DPC and thread latency experienced by the operating system and all drivers, including modem drivers~~. Implementers can verify that their driver meets this guideline by instrumenting their code to use the Pentium® processor time stamp counter model specific register or equivalent to record when non-thread driver schedulable entities (for example, ISRs, DPCs) start and stop processing~~.
- Only kernel mode threads have access to the priority range 27 through 30. This guide recommends that driver-based modems use thread priorities in the range 28 through 30, reserving thread priority 31 for short duration time critical processing by the operating system, and that non-modem thread-based drivers use thread priorities 27 and lower.

[Note to reviewers: the thread priority recommendations specified above are new to this version. Please comment.]

- The total execution time required for all DPCs enqueued by a WDM driver-based modem in response to a single interrupt should not exceed 250 microseconds.
- The maximum time during which a WDM driver-based modem continuously disables thread preemption should not exceed 600 microseconds. This guideline accommodates 100 microseconds of interrupts being disabled followed by two 250 microsecond DPCs which execute back-to-back.

  ~~The total time during which a WDM driver-based modem disables thread preemption during any 8 millisecond interval should not exceed 2.6 milliseconds. This accommodates two 600 microsecond intervals with thread scheduling disabled plus 7 **x** 200 microseconds with interrupts disabled.)~~

  Measurement: Implementers can verify that their driver meets these guidelines by instrumenting their code to use the Pentium II processor time stamp counter model specific register or equivalent.

- The following guidelines concern modem driver tolerance for hold-off from processing caused by the operating system and/or other drivers. The recommended tolerances are designed to ensure minimum degradation in modem Quality of Service (QoS) on a PC 99 system. By QoS is meant, for

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example, effective throughput, connection rate, and line drop. It is strongly suggested that driver-based modems be designed insofar as possible to degrade gracefully in the event of a longer hold-off than that indicated below by, for example, recovering from bit errors without retraining and/or stepping down to a lower speed.

[Note to reviewers: The following tolerances are based on preliminary analysis of PC 99 platforms and operating systems, and are believed to represent realistic worst-case values for the various types of hold-off to which a driver-based modem will be subjected. Please provide us with specific feedback if you believe these are not adequate.]

- A driver-based modem should be able to tolerate a continuous period with interrupts disabled of 1 millisecond~~. Furthermore it is suggested that driver-based modems be designed insofar as possible to degrade gracefully during the occurrence of a continuous period with interrupts disabled in excess of 1 millisecond~~.
- A WDM driver-based modem should be able to tolerate a continuous period with thread scheduling disabled of 9 milliseconds~~. Furthermore it is suggested that WDM driver-based modems be designed insofar as possible to degrade gracefully during the occurrence of a continuous period with thread scheduling disabled in excess of 9 milliseconds. Note: graceful degradation means that the modem should maintain the connection where possible, even if that means recovery from bit errors, or needing to retrain and/or step down to a lower speed.~~
- A WDM driver-based modem should be able to tolerate a hold-off from access to the PCI bus caused by other bus masters of 100 microseconds~~. Furthermore it is suggested that driver-based modems be designed insofar as possible to degrade gracefully during the occurrence of a hold-off from access to the PCI bus in excess of 100 microseconds~~.
- Use of page-locked memory by a V.34 or V.90 WDM driver-based modem should not exceed 5 percent of the minimum physical memory configuration ~~recommended~~ required by this guide for a Consumer PC 99 (that is, 1.6 MB out of 32 MB).

27. Driver-based modems use a WDM-based driver solution

Required

In 1999, the mainstream Windows operating systems will share the WDM kernel calls. Driver-based modems must use the WDM kernel, so that a common driver binary can be used in Windows 98 and in Windows NT 5.0. For Windows NT 5.0, these drivers shall also support SMP.

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xDSL Migration

Digital Subscriber Lines (DSL) use the copper wires from the telephone providers in new ways, to deliver high bandwidth Internet access. U.S. ANSI Standard T1.413 defines “full-rate” Asymmetric Digital Subscriber Line (ADSL) procedure, for high-end operation at download speeds up to 6 Mbps. Recently, industry collaboration in the ANSI T1 committee and in ITU Study Group 15 has commenced on a “G.lite” DSL standard for lower-rate, consumer-friendly DSL that does not require a service call from the telephone provider to the user’s residence.

These “G.lite” devices deliver Asynchronous Transfer Mode (ATM) services from the PSTN to the customer. The recommended interface from a DSL device to a PC is as an ATM device, using an NDIS mini-port, as described in the Networking chapter in Part 4 of this guide.

PC 99 Design for Modems

This section summarizes PC 99 requirements related to the design initiatives in Part 1 of this guide.

Plug and Play and Bus Design for Modems

The items in this section are requirements for Plug and Play capabilities.

28. Each device has a unique Plug and Play device ID
Required

For a system-board device, there must be a device-specific ID.

Each bus-specific device must provide device IDs in the manner required for the bus it uses as defined in Part 3 of this guide. For example, PCI devices must comply with the current PCI requirements and also must provide a Subsystem ID and Subsystem Vendor ID as defined in the “PCI” chapter in Part 3 of this guide.

Note: The device must implement either a bus Plug and Play ID or a COM-port Plug and Play ID, but not both.

29. Each device has a compatible Plug and Play device ID
Required

The various bus-specific Plug and Play specifications provide the means for reporting a CompatibleID as well as a device unique ID.

At least one CompatibleID is required for PC 99. Its primary use is for back up in case the driver or INF file associated with the unique ID is not available (for example, if the customer lost the disk). The goal is for the modem to retain essential data functionality.

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The most useful Compatible IDs would point either to an earlier version of the same product (whose INF file is included in shipping versions of Windows) or point to a reference INF file (that is, one provided by the modem chip-set manufacturer).

30. Automatic resource assignment and dynamic disable capabilities are supported

Required

The system must be capable of automatically assigning, disabling, and relocating the resources used by this device when necessary, using the method required for the related bus class. When the end user changes this device or adds it to the system, setting resource assignments must not require changing jumpers or switches on either the adapter or the system board. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable the device to prevent the system from stalling.

31. PCI modem meets current requirements

Required

This device must comply with PCI 2.1 or later if PCI is used as the bus connection for the modem. If PCI is the current version, the power management extensions also must be supported. This ensures that all Plug and Play requirements are met and that Windows and Windows NT drivers support this device.

32. USB modem meets USB specifications

Required

As required for all PC 99 devices, a modem must meet the specific requirements for the bus it uses, including any device class specifications. For example, a modem that uses USB must comply with all related USB specifications, including:

- *USB Specification, Version 1.0* or later (also known as the USB core specification)
- *Universal Serial Bus Device Class Definition for Communication Devices, Version 1.0* or later
- For USB modems that incorporate the modem controller function, the modem must support the mandatory and optional requests and notifications for Abstract Control Model Serial Emulation in section 3.5.1.2.1 of the *USB Class Definitions for Communication Devices Specification* for compatibility with Unimodem and Windows USB serial drivers

33. Device Bay modem meets PC 99 requirements

Required

A modem designed as a Device Bay peripheral must interface with either USB, IEEE 1394, or both buses, and must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay Interface Specification, Version 1.0* or later.

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Power Management for Modems

This section summarizes the modem power management requirements. See also the specific power management requirements for each bus defined in Part 3 of this guide.

34. Device complies with device class power management reference specification

Required

The *Communications Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for these devices, including modems. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class.

Power states D0 and D3 are required for modems on power-managed buses, including PCI, CardBus, and USB.

Modem adapters that use the PCI bus must be capable of generating a power management event (PME# assertion) from the D3 cold device state. It is recommended that modem adapters also support capture of Caller ID with hardware support for the AT+VRID, “resend caller ID,” voice modem command.

35. Device supports wake-up events

Required

For PC 99, a required modem feature is the ability to cause a wake-up event on an incoming ring as defined in *Communications Device Class Power Management Reference Specification.* Notice that this applies for modems on power-managed buses, including PCI, CardBus, and USB.

The D2 power state is defined specifically for this purpose in the power management reference specification. The ability for a modem to cause a wake-up event from the D3 power state might also be possible and is recommend to realize better system power savings. To comply with this requirement, a modem must be able to cause a wake-up event from either the D2 state, the D3 state, or both states.

Because caller-ID reporting would be missed by PCs while in a sleep state, the ability for a modem to retain and repeat the last caller-ID reporting on demand is recommended. The mechanism for doing this is described in *Communications Device Class Power Management Reference Specification* and in the ~~V.voice and TIA-695~~V.253 voice modem specifications.

Device Drivers and Installation for Modems

This section summarizes device driver requirements for modems. The items in this section are requirements for all PC 99 systems.

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36. Device drivers and installation meet PC 99 requirements
Required

The manufacturer does not need to supply a driver if a PC 99-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, the requirements for the device drivers and installation are defined in the "PC 99 Basic Requirements" chapter in Part 2 of this guide. The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

For information about support for controllerless and software modems under WDM, see the Windows NT 5.0 DDK. See also the related articles at http://www.microsoft.com/hwdev/desinit/. For information about WDM-based modem driver support under Windows NT, see the Windows NT 5.0 DDK.

For guidelines about implementing driver and installation support for modems under the Windows operating system, see the Windows MDK.

37. Driver supports Unimodem
Required

The device driver must include Unimodem support. Typically, this requires a modem INF file, developed and verified using the MDK and pretested by the modem manufacturer.

38. Applications provided with device meet Win32 requirements
Required

Any Windows-based applications provided with the device, such as fax utilities, must meet requirements for software compatibility as defined in the Microsoft Platform SDK.

As an API, the Windows Telephony API (TAPI) is the cornerstone of telephony for Windows and Windows NT. Telephony applications and service providers provided with PC 99 systems must be implemented using TAPI 2.0.

Among other enhancements, applications can request, negotiate, and renegotiate QOS parameters with the network and receive indication of QOS on inbound calls and when QOS is changed by the network. For a summary of the TAPI 2.0 architecture and a description of how to write a TAPI service provider, see http://www.microsoft.com/ntserver/communications/. For implementation information, see the Microsoft Platform SDK.

Modem References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

ANSI, EIA, TIA, and other standards
Global Engineering Documents
Phone:+1 (800) 854-7179 (US)

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+1 (613) 237-4250 (Canada)
+1 (303) 792-2181 (Outside North America)
Fax: +1 (303) 397-2740
ftp://ftp.symbios.com/pub/standards/io/

Bellcore Technical References
Bellcore (Bell Communications Research)
Phone: +1 (800) 521-2673 (North America)
+1 (908) 699-5800 (Outside North America)
http://www.bellcore.com

Communications Device Class Power Management Reference Specification, Version 1.0
http://www.microsoft.com/hwdev/onnow.htm

Device Bay Interface Specification, Version 1.0
http://www.device-bay.org

European Telecommunications Standards Institute (ETSI) or Global System for Mobile (GSM) standards
Phone: +33-92 94 42 00
FAX: +33-93 65 47 16
E-mail: secretariat@etsi.fr

ITU communications standards
ITU Sales
Phone: +41 (22) 730-6141
Fax: +41 (22) 730-5194
E-mail: sales@itu.ch
http://www.itu.ch

PCI Local Bus Specification, Revision 2.1 (PCI 2.1)
http://www.pcisig.com

Plug and Play specifications
http://www.microsoft.com/hwdev/specs/

Telephony API (TAPI) overview and white papers
http://www.microsoft.com/ntserver/communications/
http://www.microsoft.com/win32dev/netwrk/tapiwp.htm

Unimodem Diagnostics Command Reference Specification
Unimodem ID Command Reference Specification
http://www.microsoft.com/hwdev/specs/

USB specifications
http://www.usb.org

WDM device driver support white papers
http://www.microsoft.com/hwdev/desinit/

Windows MDK
ftp://ftp.microsoft.com/developr/drg/modem/modemdev.exe

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Windows and Windows NT DDK, including information about NDIS and Microsoft Platform SDK

MSDN Professional membership

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Checklist for Modems

If a recommended feature is implemented, it must meet the PC 99 requirements for that feature as defined in this document.

Consumer PC 99	Office PC 99	Entertainment PC 99
1. Modem device is provided with PC system		
Required	*Required, if no network adapter*	*Required*
2. Modem supports V.250 AT command set		
Required		
3. Data modem supports V.90 (1998) analog modem modulation		
Required		
4. Data modem supports Annex A/V.34-(1998) Seamless Rate Change		
Required		
5. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set		
Required		
6. Data modem supports V.42 LAPM, V.42 bis, V. 80 Synchronous Access data protocols		
Required		
7. Modem supports V.8 bis call control signaling, controlled via V.251 modem commands		
Required		
8. Modem supports delayed and blacklisted number clearing		
Recommended		
9. Modem supports TDD, meeting V.18-1996 with V.250 AT commands		
Recommended		
10. Modem controller meets PC 99 requirements		
Required		
11. Voice modem supports ITU V.253 (AT+V)		
Required (in modems supporting voice)		
12. Voice modem support includes PC 99 recommendations		
Recommended		
13. Modem supports Caller ID Detection and Reporting		
Recommended		
14. Voice modem supports speakerphone		
Recommended		
15. Wireless support implemented for modems		
Recommended		
16. Digital cellular phone support is implemented for modems		
Recommended		
17. ISDN modem supports required command set		
Required		
18. ISDN modem exposes both B channels		
Recommended		
19. ISDN modem supports asynchronous-to-synchronous conversion		
Required		

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20. ISDN modem defaults to HDLC PPP after INF installation.
Recommended

21. ISDN modem uses high-speed port
Recommended

22. ISDN driver supports unattended installation, with limitations
Required

23. Modem pair passes basic V.34 file transfer test
Required

24. Modem pair passes basic call connect reliability test
Required

25. Modem pair passes concurrency test
Required

26. Software modem meets PC 99 performance criteria
Recommended

27. Driver-based modems use a WDM-based driver solution
Required

28. Each device has a unique Plug and Play device ID
Required

29. Each device has a compatible Plug and Play device ID
Required

30. Automatic resource assignment and dynamic disable capabilities are supported
Required

31. PCI modem meets current requirements
Required

32. USB modem meets USB specifications
Required

33. Device Bay modem meets PC 99 requirements
Required

34. Device complies with device class power management reference specification
Required

35. Device supports wake-up events
Required

36. Device drivers and installation meet PC 99 requirements
Required

37. Driver supports Unimodem
Required

38. Applications provided with device meet Win32 requirements
Required

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